A Lagrangian study of pathways and mixing of Arctic and Atlantic water in the southern Norwegian Sea

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Background

•The Iceland Faroe Front (IFF) separates the cold waters of the East Iceland Current from the warm Atlantic waters that enters the Nordic Seas between Iceland and the Faroes.

•The dynamics of the IFF is poorly understood (Allen et al., 1994).

•The AIW manifests itself as a salinity minimum in the water column, with salinities typically in the range 34.87-34.90

•AIW has been expanding in volume in recent decades. In 1958 the AIW was only observed in the western part of the Norwegian Sea, whereas in 1997 the water mass was present on the entire section (see Fig. 2.)(Blindheim et al., 2000).

•The AIW now blanket the entire Norwegian Sea and thus preclude direct contact between the warm surface waters and the dense deep waters.

•At the eastern corner of the Faroe Plateau the upper and lower limbs of the thermohaline system come into very close proximity. The warm Atlantic waters continues northeast crossing over both the AIW and Norwegian Sea Deep Water. (Poulain et al., 1996).

•Some of the AIW escapes from the Norwegian Sea as the upper fraction of the overflow through the Faroe-Bank Channel, but a major fraction of the AIW turns north and flows northward below and partially to the west of the outer branch of the Norwegian Atlantic current. Orvik et. al. (2001)

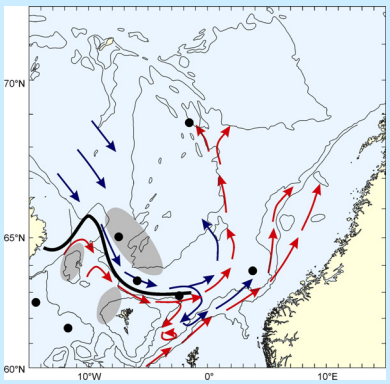

Figure 1. Indication of the position of the Iceland - Faroe Front (thick solid line). The circulation of warm Atlantic waters (red arrows) and Arctic waters (blue arrows). Planned positions for sound sources are shown by black circles. Grey areas indicate planned deployment sites for RAFOS floats.

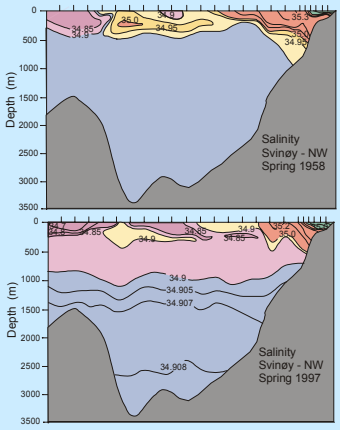

Figure 2 Salinity in an extended Svinøy section for 1958 (upper) and 1997 (lower). Distribution of AIW is shown as purple area.

Objectives

The main objectives in the project are to investigate the inflow and diffusive modification of the transport of warm saline water across the Iceland-Faroe ridge north into the Norwegian Sea and and the spreading of the Arctic Intermediate Water (AIW) and its interaction with the warm Atlantic waters in the Norwegian Sea.

Project goals

•From where do the warm waters in the IFF come and where do they go?

•What is the relative contribution of water from the Iceland and Faroes sides?

•How does the IFF transport the warm waters north?

•Map the circulation pattern of the AIW.

•What are the relative roles of advection and mixing in the transport of these waters in the IFF and the southern Norwegian Sea.

•Determine residence time and the importance of cross frontal mixing.

•Investigate seasonal variations.

•Establish Norwegian expertise in the technology and use of acoustically tracked subsurface drifters for the study of ocean circulation and mixing processes.

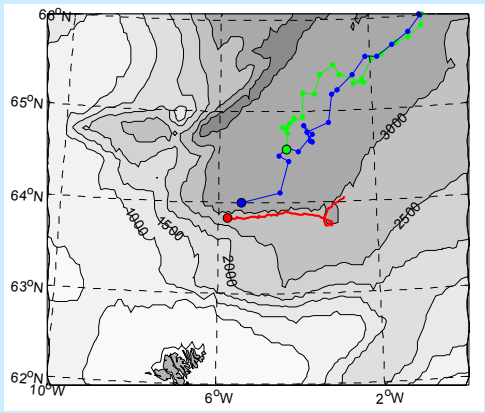

Figure 3 Two Argo-floats at 1500m depth are shown in blue and green. There are 10 days between each dot. RAFOS float at 800m depth, 40 day trajectory shown in red, two positions each day. Circles show first positions. All floats were deployed in July 2003. Note the higher resolution in the RAFOS float track and the small loop it makes.

Field programme

•To reach the objectives and goals we will deploy 60 RAFOS floats in the warm Atlantic water in the IFF and 30 RAFOS floats in the AIW in the southern Norwegian Sea.

•In the summer of 2003 7 sound sources were deployed, but due to technical problems the moorings were retrieved already in October 2003.

• The 7 sound sources will be redeployed from a National Science Foundation (NSF) ship in September 2004 (See Fig 1. For location). At the same time hydrographic mapping will be carried out and RAFOS floats will be deployed .

•RAFOS floats will be deployed in a sequential manner off Iceland and the Faroes .

•The RAFOS floats in the warm Atlantic water and in the AIW will have a target depths of 200 and 600m respectively.

•The RAFOS floats will remain in the water from 6 to 18 months.

•The IMR also occupies the Svinøy section at least five times a year in their ongoing ocean monitoring programme.

•In May and August each year the IMR are doing a survey of the herring stock and the distribution of zooplankton in the Norwegian Sea. The accompanying CTD survey will also be a valuable tool to interpret the float data as it gives the horizontal distribution of temperature and salinity in the upper 1000m

•After all the RAFOS floats have surfaced the sound sources will be retrieved by IMR ships in 2006.

•The project is a cooperative effort between URI and IMR/BCCR. The URI component focuses on the IFF and is funded by NSF, and the BCCR component focuses on the AIW and is funded by BCCR and IMR provide ship time.

•Some preliminary results are presented in figure 3-6.

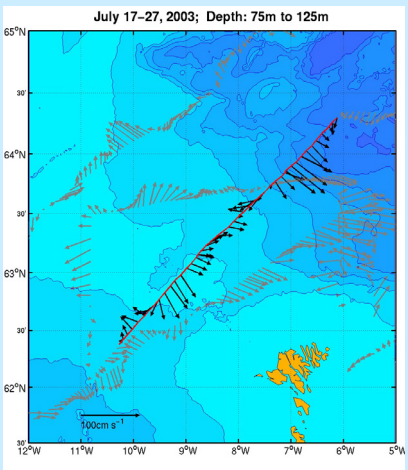

Figure 4 Mean flow between 75 and 125m measured with ADCP on the Johan Hjort cruise in July 2003. The ADCP sections show the water in the IFF flowing south east along the northern slope of the Iceland Faroe ridge. Red line shows location of vertical sections of cross track velocity (Fig 5) and salinity (Fig.6).

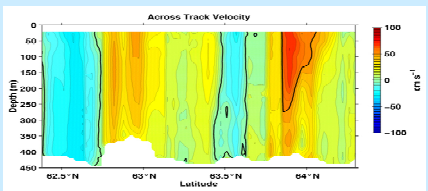

Figure 5. Vertical cross section of the cross track current (see Fig. 4).The baroclinic structure with strong vertical shear is associated with the shoaling pycnocline (Fig. 5) on the northern side. The peak velocity is 0.7ms^{-1} and the total south eastward transport north of 63.6°N in the upper 400m of the section is 2.9Sv.

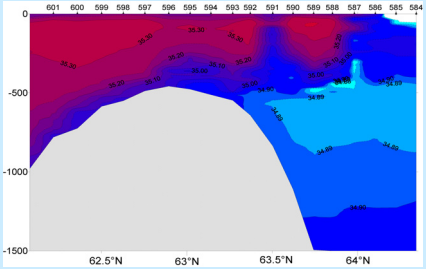

Figure 6. Vertical cross section of the salinity (see Fig. 4). The high velocities are associated with the of high salinities in the upper 400m on CTD stations 588-590.

References

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